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Limited utility of routine early postoperative radiography after primary ACL reconstruction

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ABSTRACT

Background: Given the overall success of anterior cruciate ligament (ACL) reconstruction and the infrequent occurrence of complications detectable on radiographs, the clinical utility and cost-effectiveness of routine radiographs in the early postoperative setting is questionable.
Methods: Nine hundred thirty-three consecutive adult patients undergoing uncomplicated ACL reconstruction at a single institution were retrospectively reviewed to determine whether a postoperative knee radiograph was obtained within the first three months postoperatively. Images, reports and clinical notes were reviewed to determine if any clinical management change occurred due to x-ray findings. Radiograph charges, including imaging, technical and professional charges were calculated.
Results: Five hundred ninety-nine of 933 primary ACL reconstruction patients (64.8%) had postoperative knee radiography at an average of 6.3 ± 3.5 weeks postoperatively. A musculoskeletal radiologist read 97.7% of x-rays as normal. In the associated visit note, 70.3% of x-ray results were documented. Only 14.1% of patients with a postoperative x-ray had subsequent imaging. There were no significant management changes based on the routine postoperative radiographs using the defined criteria. A total of $336,683 ($562 per patient) was billed to patients for postoperative radiographs.
Conclusions: Routine early postoperative radiography after primary ACL reconstruction is of questionable utility. The significant per-patient expense is not balanced by the low yield of clinically meaningful data, as nearly all radiographs in the present series were normal and none resulted in significant changes in postoperative clinical management. These results suggest that routine radiographs after uncomplicated ACL reconstruction may be unnecessary although larger, multicenter studies are necessary to confirm these findings.
Level of evidence: Level IV, retrospective case series.

1. Introduction

Postoperative radiographs are routinely obtained in many medical centers after ambulatory sports medicine procedures such as anterior cruciate ligament (ACL) reconstruction despite lack of evidence supporting such a practice [1–3]. Given the overall success of this procedure and the infrequent occurrence of complications detectable on radiographs, the clinical utility and cost-effectiveness of routine radiographs in the early postoperative setting is questionable [4–8].

Numerous studies have found little utility or economic justification for the use of routine postoperative imaging after other orthopedic procedures, including both total knee and total hip arthroplasty [9–15]. Recent studies have also not demonstrated any cost benefit or clinical utility in obtaining routine radiography following either cervical or lumbar spine procedures up to a year postoperatively [16–19]. Similar conclusions have been made regarding the routine use of immediate postoperative radiography following total shoulder arthroplasty [20]. Non-orthopedic disciplines have come to similar conclusions regarding the use of routine post-procedure radiography in asymptomatic or uncomplicated cases [21–23].

Reducing wasteful spending and eliminating unnecessary risk are important issues that are at the center of the current shift toward value-based orthopedic care delivery. There is substantial redundancy and waste existing in the current practice of orthopedic surgery, and excessive postoperative imaging is one redundancy that can potentially be eliminated without significant negative clinical effects.

The purpose of the present study was to comprehensively assess the clinical utility and cost-effectiveness of early postoperative radiographs after uncomplicated ACL reconstruction. We hypothesized that there is limited clinical utility of routine radiographs in this setting with significant associated cost, making their cost utility low.

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2. Material and methods

After obtaining Institutional Review Board approval, a retrospective chart review was performed on all patients who underwent arthroscopic-assisted ACL reconstruction (CPT 29888) in the past 12 years for all orthopedic sports medicine surgeons at a single institution. Once the appropriate patients were identified by CPT code, a chart review was performed to identify epidemiologic data, other procedures performed (including meniscal repair or meniscectomy, microfracture), details of the operation performed (including type of graft and implant in ACL patients), as well as any available postoperative follow-up information, including complications.

The inclusion criteria was 1) having undergone arthroscopic-assisted ACL reconstruction between 2000 and 2013. The exclusion criteria was 1) imaging no longer available in PACS system for review, 2) multiple ligament reconstruction, 3) concomitant high tibial osteotomy or 4) revision procedure. One thousand one hundred twenty patients met the inclusion criteria and 187 were excluded (97 revision ACL reconstructions, 83 multiligament knee reconstructions, seven concomitant high tibial osteotomy), leaving 933 available for final data analysis. Demographic and operative information for the final cohort is presented in Table 1.

A retrospective evaluation of postoperative radiographs and radiologist reports was completed for all included patients. Patients were considered to have had early postoperative radiography if an x-ray of the operative knee was obtained within three months postoperatively. Postoperative radiographs were first classified as "normal" or "abnormal" based on the radiologist's read. Second, the postoperative clinic notes were reviewed to assess if radiograph results or radiologist reads were documented. Lastly, the results of the radiograph were assessed to determine if the radiograph yielded a clinically significant impact. A radiograph was considered to have caused a change in management if any of the following criteria were met: 1) notation of postoperative fracture requiring intervention, 2) notation of postoperative effusion not noted on physical examination that led to aspiration, 3) notation of malpositioned hardware that led to eventual revision surgery or patient counseling, 4) notation of aberrant ACL tunnel placement that resulted in patient counseling, change in physical therapy, or later graft instability, or 5) initial radiograph was referred to in a later radiograph or magnetic resonance imaging (MRI) for comparison (i.e., later radiograph noted to have tunnel widening based on comparison to initial postoperative radiograph). Cost was determined by obtaining 2013 institutional charges and Medicare reimbursement rates for knee radiographs based on number of views obtained (CPT 73560, 62, 64).

The primary outcome variable was if postoperative radiographs lead to a change in management as defined above. The secondary outcome variables were 1) radiologist read of postoperative x-ray ("normal" or "abnormal"), 2) documentation of radiograph interpretation or radiologist read in note, 3) total hospital charges for radiographs, and 4) total Medicare reimbursement for radiographs.

Table 1
Cohort characteristics.

Patient demographics	
Age (yrs, avg. ± S.D.)	28.7 yrs ± 12.2 yrs
Gender (n, % male)	356 (59.4%)
BMI (kg/m^2, ± S.D.)	27.8 ± 7.1
Laterality (n, % right)	291 (48.6%)
Operative details	
Graft	
Hamstring autograft (n, %)	468 (78.1%)
Patellar tendon autograft (n, %)	126 (21.0%)
Allograft (n, %)	5 (0.8%)
Femoral fixation	
Interference screw (n, %)	193 (32.2%)
Suspensory (n, %)	186 (31.1%)
Cross pin (n, %)	220 (36.7%)
Tibial fixation	
Interference screw (n, %)	594 (99.2%)
Cross pi n (n, %)	5 (0.8%)
Postoperative x-rays	
Number of x-rays	
1 (n, %)	490 (81.8%)
2 (n, %)	76 (12.7%)
3 (n, %)	22 (3.7%)
4 (n, %)	8 (1.3%)
5 (n, %)	3 (0.5%)
>5 (n, %)	0 (0.0%)

Key:
yrs: years
avg: average
S.D.: standard deviation
BMI: body mass index
kg: kilograms
m: meter

3. Results

Five hundred ninety-nine (64.8%) of the 933 patients included in the study had postoperative knee radiographs obtained at an average of 6.3 ± 3.5 weeks postoperatively. Demographic and operative details for the 599 patients who had early postoperative radiographs are presented in Table 1. Normal postoperative findings were reported in 97.9% (592/599) of the radiographs, and only 70.3% (418/599) of the radiographs were mentioned in a postoperative clinic note. If two sets of knee radiographs were obtained in the postoperative period, the first one was mentioned in comparison in 67.1% (57/84) of the cases. The number of postoperative radiographs obtained for patients, which ranged between one and five total, is presented in Table 1. The majority of patients had a single postoperative radiograph (81.8%).

Radiopaque femoral fixation was placed in 56.2% (311/599) of the knees with postoperative radiographs and radiopaque tibial fixation in 21.5% (119/599) of the knees with postoperative radiographs. No additional procedures were performed in any patients that required radiopaque fixation or implants. The details of the type of femoral and tibial fixation used are included in Table 1. There were no intraoperative complications.

No changes in postoperative management or rehabilitation were made based on the postoperative radiographs. A total of $336,683 was billed to patients for postoperative x-rays, which equates to an average of $562 per patient with radiographs.

4. Discussion

Fiscal responsibility has become an important objective for efficient and efficacious health care. As reimbursements decline and bundled care initiatives gain traction, appropriately allocating monetary resources is imperative for the long-term survival of individual practices and the health care systems. The present study found that routine early postoperative radiography after uncomplicated primary ACL reconstruction does not appear to be cost-effective. The significant per-patient expense was not balanced by the low yield of clinically meaningful data, as nearly all radiographs in the present series were normal, subsequent imaging was rarely obtained and no imaging resulted in significant changes in postoperative clinical management.

Previous studies in other orthopedic subspecialties have found that routine postoperative imaging is obtained too frequently and without benefit to the patient. Glaser and Lotke evaluated early postoperative imaging following total knee arthroplasty (TKA) [9]. Of the 192 radiographs in a cohort of patients who had radiographs prior to discharge, none altered the management of these patients, and the authors noted that only 36% of those images were of sufficient quality to even provide an accurate baseline for further studies. The second cohort of 550 patients who only obtained imaging at their first postoperative clinic visit did not experience any adverse outcome as a result of delayed imaging. This finding has been echoed in prior studies that also found minimal utility for routine TKA imaging prior to discharge and suggested that the low quality of portable techniques is partly to be blame [10–12].

Early radiographic evaluation following spine surgery has also been found to have little utility. For single level cervical or lumbar fusion